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## (54) Laminate for magnetic core.

(57) A magnetic core lamina A of unitary construction is disclosed and claimed. The lamina comprises an elongate intermediate formation 1 and a pair of loop formations 2 disposed on opposite sides of the intermediate formation. Each loop formation extends from opposite end regions 1.1 and 1.2 of the intermediate formation and defines with the intermediate formation an aperture 3. The lamina is characterised in that the intermediate formation 1 is severed across its entire width in a zone 9 at the one end 1.1 of the intermediate formation. A magnetic core and a stationary electric machin including a magnetic core comprising a stack of laminae of the kind described hereabove, are also disclosed and claimed.

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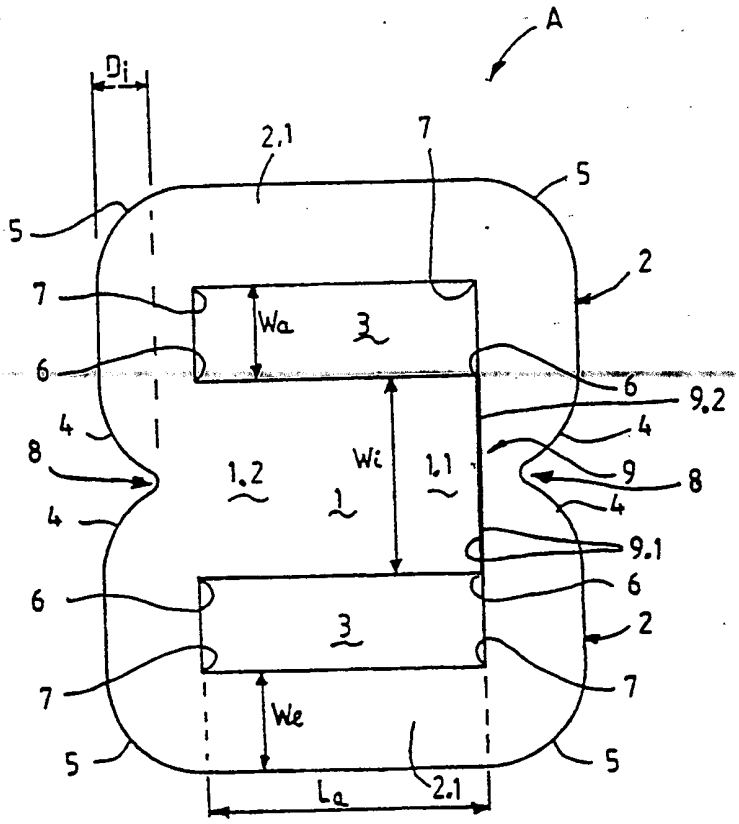


FIG 1

## BACKGROUND OF THE INVENTION

THIS invention relates to laminated magnetic cores suitable for transformers, chokes, lighting equipment ballasts and the like.

## SUMMARY OF THE INVENTION

According to to the invention there is provided a core lamina of unitary construction comprising an elongate intermediate formation and a pair of loop formations disposed on opposite sides of the intermediate formation, each loop formation extending from opposite end regions of the intermediate formation and defining with the intermediate formation an aperture through which part of at least one coil may extend, the lamina being characterised in that the intermediate formation is severed across its entire width in a zone towards one end of the intermediate formation.

The intermediate formation is preferably severed in a straight line substantially perpendicular to a longitudinal axis of the elongate intermediate formation and at the one end of the intermediate formation.

Further according to the invention there is provided a core lamina of unitary construction comprising an elongate intermediate formation ; and a pair of loop formations disposed on opposite sides of the intermediate formation, each loop formation extending from opposite end regions of the intermediate formation and defining with the intermediate formation an aperture through which part of at least one coil may extend, the intermediate formation being severed across its entire width in a zone towards one end of the intermediate formation so that the intermediate formation on the one hand and the combined or joined loop formations on the other hand are relatively displaceable transversely to a plane of the lamina in the region of the one end of the intermediate formation, thereby to permit the intermediate formation to be introduced from the one end thereof into a bore of a coil and to locate the coil round the intermediate formation with the loop formations embracing opposite regions of the coil.

Thus, with the lamina according to this invention, there is provided less limbs with free ends and only one severed zone, making the lamina less prone to permanent deformation when it is mounted in a coil assembly. Furthermore, as the severed zone is in a straight line across the entire width of the intermediate formation, the lamina according to the present invention is easier to manufacture by stamping it out of a plate f a suitable material.

The intermediate formation and the loop formations ar pref rably biased by inherent resilience of the lamina to return from the said relatively displaced positions to normal positions in which the portions of th lamina on opposite sides of the severed zone are located substantially in alignment defining an airgap therebetween.

The intermediate formation pr ferably has a substantially uniform width throughout its length and each of the loop formations has a substantially uniform width throughout its length, the width of each loop formation being substantially half the width of the intermediate formation.

The aperture defined by each of the loop formations and the intermediate formation may have an elongate, substantially rectangular configuration, each loop formation embracing the associated aperture and including an elongate outer portion extending along the rectangular aperture.

Each loop formation preferably has rounded outer corner zones opposite corners of the said associated rectangular aperture such that the width of each loop formation is substantially uniform throughout its length.

The width of each rectangular aperture may be substantially equal to the width of the loop formation and the length of the aperture preferably is at l ast three times the width thereof.

The core lamina according to the invention preferably has a lattened figure-of-eight configuration.

Also included within the scope of this invention is a laminated core for a transformer, choke, lighting equipment ballast or like stationary electric machine comprising a stack of superimposed core laminae as defined hereinbefore.

In the most preferred form of the core a severed zone of a lamina of the stack is sandwiched between regions of adjacent laminae which are not severed.

Also included within the scope of this invention is a transformer, choke, lighting equipment ballast or like electric machine including a laminated core as defined in any one of the preceding two paragraphs.

## BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the core lamina according to the invention will now be described, by way of example only, with reference to the accompanying diagrams wherein :

**figure 1 :** is a face view of a core lamina according to the invention which has a flattened figure-of-eight configuration ;

**figure 2 :** is a diagrammatic perspective view from one end of a preformed tubular coil assembly for a transformer, illustrating the mounting of a lamina similar to that of figure 1 on th coil assembly to form a laminated core ; and

**figure 3 :** is a diagrammatic perspective view to an enlarged scale of the coil assembly of figure 2, illustrating the stacking of a plurality of laminae according to the invention to form a laminated core for the coil assembly.

## DESCRIPTION OF PREFERRED EMBODIMENT

Referring first to figure 1, the lamina A is of unitary construction and is stamped out of a plate of any suitable magnetic material, such as ferro-silicon steel. Lamina A has a flattened figure-of-eight configuration and comprises an elongate intermediate formation 1 which has a uniform width throughout its length ; and a pair of loop formations 2 which are disposed on opposite sides of the intermediate formation 1. Each loop formation 2 extends from opposite ends of the intermediate formation 1 and has a substantially uniform width throughout its length.

Each loop formation 2 defines, together with the intermediate formation 1, an elongate rectangular aperture 3 through which part of a coil may extend. Each loop formation 2 has an elongate outer portion 2.1 which extends along the associated elongate aperture 3. Each loop formation has rounded outer corner zones 4 and 5 opposite the inner and outer corners 6 and 7, respectively of the associated rectangular aperture 3, so that the width of each loop formation 2 is substantially uniform throughout its length. It will be seen that at opposite ends of intermediate formation 1, the two loop formations 2 are joined to each other. Radiused indentations 8 are defined between the two loop formations 2 in the zones where they are joined at opposite ends of intermediate formation 1.

The intermediate formation is severed across its entire width in a position at the one end 1.1 of the intermediate formation 1 along a line 9 extending perpendicular to the longitudinal axis of the intermediate formation between opposed inner corners 6 of the apertures 3 on either side of intermediate formation 1. Neither the loop formation 2, nor the intermediate formation 1 is severed in the region of the opposite end 1.2 of the intermediate formation 1, so that the loop formations 2 are fast with the intermediate formation 1 in the region of its opposite end 1.2, thereby to provide a lamina of unitary construction.

In a preferred embodiment of the invention the width $W_e$ of the two loop formations 2 are equal to each other and are equal to half of the width $W_i$ of the intermediate formation 1. The widths $W_a$ of the two apertures 3 are equal to each other and to the widths $W_e$ of the loop formation 2. The lengths $L_a$ of the two apertures 3 are equal to each other and are at least three times the widths $W_a$ of the apertures 3.

The width $W_i$ of intermediate formation 1 and the widths $W_e$ of the two loop formations 2 are selected to suit a required power output of a transformer including a core comprising a stack of laminae similar to lamina A. The lengths $L_a$ of the apertures 3 are suitably selected in relation to the widths $W_e$ of the apertures 3 so that the apertures 3 may accommodat a coil having a suitable number of turns and/or a suitable conductor cross-sectional area as required for a particular application.

The radiused indentations 8 have a d pth $D_i$ of in the order of 55% of the width $W_e$ of the loop formations.

A laminated core may be produced by superimposing a plurality of similar laminae A to form a stack of laminae in registration with each other.

As shown in figures 2 and 3, a transformer may be produced with a core comprising a stack of laminae similar to lamina A of figure 1. For this purpose a preformed coil assembly B of tubular configuration which comprises a primary winding 10 and a secondary winding 11, is provided.

A plurality of laminae A are mounted successively one after the other on the coil assembly B. As shown with reference to lamina $A_2$ in figure 2, each lamina is mounted by transversely displacing the intermediate formation 1 on the one hand and the joined loop formations 2 on the other hand away from one another in the region of the one end 1.1 of the intermediate formation 1 of the lamina. The intermediate formation 1 of the lamina is then introduced into the bore 12 of the coil assembly B from one end 13 thereof and the loop formations 2 are passed over and round the coil assembly B so that the one end 1.1 of the intermediate formation 1 protrudes from the opposite end 14 of the coil assembly B. The intermediate formation 1 and the loop formations 2 are then pushed back or allowed to spring back under the influence of the inherent resilience of the material of the lamina A, from their displaced positions to their normal positions in which parts of the lamina on opposite sides of the zone 9 in which the intermediate formation 1 is severed, are located in alignment. The lamina is then completely flat with opposed edges 9.1 on opposite sides of the severed zone 9 disposed in closely matching relationship to provide an airgap 9.2 of uniform and minimum width.

Each successive lamina may be mounted on coil assembly B as described above to form a stack 15 of superimposed laminae A which fills the bore 12 of coil assembly B. The stack 15 of laminae A constitutes a laminated core for coil assembly B.

In order to avoid the severed zones 9 of all th laminae A in the stack 15 from being superimposed in vertical registration with one another, It is preferable for the intermediate formations 1 of successive laminae A to be introduced into the bore 12 of coil ass mbly B alternately from the one end 13 of the coil assembly as shown in figure 2 and from the opposite end 14 of the coil assembly B as shown in figure 3, so that the severed zone 9 of one lamina near the ne nd 1.1 of its intermediate formation is sandwiched between regions of a pair of adjacent laminae which are located near the opposite ends 1.2 of the intermediat formati ns 1 of the adjacent laminae A and which are not severed.

Once all the laminae A in th stack 15 have been mounted on coil assembly B to fill th bore 12 of the

coil assembly B, th sup rimposed laminae A in th stack may be firmly clamped togeth r in any suitable manner to provide a laminated core for the coil assembly B. Upper and lower clamping plates (not shown) may be provided for this purpose. Bolts (also not shown) for urging the clamping plates towards one another may pass through the registering indentations 8 at the opposed ends of the stack 15.

The lamina A according to the invention has rounded external corner zones 4 and 5 to present a double magnetic circuit having such a configuration that it enhances the flow of magnetic flux round the two circuits and avoids or at least minimizes an escape of magnetic flux from the lamina and flux vortices in the zones where the two magnetic circuits meet towards opposite ends of the intermediate formations 1 in the zones of the indentations 8.

It will be appreciated that in contradiction with most known lamina, the lamina A according to the invention need not have any holes therein, for receiving clamping or securing bolts which holes are located in the flux path presented by the lamina and which tend to reduce the effective cross-sectional area of the flux path and also tend to cause flux vortices in the lamina and eddy currents in the securing bolts.

An improved efficiency may thus be obtained from a laminated core comprising a stack of laminae A according to the invention. Also, mechanical noise in the laminae, stray magnetic losses from the core and electro-magnetic coupling with adjacent components may be minimized. Furthermore, laminae according to the invention facilitates mounting of a core on a preformed coil assembly.

Still furthermore, with the lamina according to the present invention, which is severed in a single zone in the relatively wide intermediate formation, possible permanent deformation in the region of the severed zone after mounting of the lamina on a tubular core may be reduced and thus better alignment of the opposed edges on opposite sides of the severed zone may be achieved, to provide a single uniform airgap in the severed zone.

It will be appreciated that there are many variations in detail on the core lamina according to the invention without departing from the scope and spirit of the appended claims.

## Claims

1. A core lamina of unitary construction comprising an elongate intermediat formation and a pair of loop formations disposed on opposite sides of the intermediate formation, ach loop formation extending from opposite end regions of the intermediate formation and defining with the intermediate formation an aperture through which part of at least ne coil may extend, the lamina being characterised in that th intermediate formation is severed across its ntire width in a zone towards on end of the intermediate formation.

2. A core lamina as claimed in claim 1 wherein the intermediate formatio is severed in a straight lin substantially perpendicular to a longitudinal axis of the elongate intermediate formation and at the one end of the intermediate formation.

3. A core lamina of unitary construction comprising an elongate intermediate formation ; and a pair of loop formations disposed on opposite sides of the intermediate formation, each loop formation extending from opposite end regions of the intermediate formation and defining with the intermediate formation an aperture through which part of at least one coil may extend, the intermediate formation being severed across its entire width in a zone towards one end of the intermediate formation so that the intermediate formation on the one hand and the loop formations on the other hand are relatively displaceable transversely to a plane of the lamina in the region of the one end of the intermediate formation, thereby to permit the intermediate formation to be introduced from the one end thereof into a bore of a coil and to locate the coil round the intermediate formation with the loop formations embracing opposite regions of the coil.

4. A core lamina as claimed in claim 3, wherein the intermediate formation and the loop formations are biased to return from the said relatively displaced positions to normal positions in which portions of the lamina on opposite sides of th severed zone are located substantially in alignment and defining an airgap therebetween.

5. A core lamina as claimed in claim 4, wherein closely matching edges located in close proximity to each other are provided on opposite sides of the airgap.

6. A core lamina as claimed in any one of claims 3 to 5 wherein the intermediate formation is severed in a straight line substantially perpendicular to a longitudinal axis of the elongate intermediate formation and at the one and of the intermediate formation.

7. A cor lamina as claimed in any one of the preceding claims, wherein the intermediate formation has a substantially uniform width throughout its length and each of the loop formations has a substantially uniform width throughout its length, the width of each loop formation being substantially half the width of th

intermediate formation.

8. A core lamina as claimed in any one of the preceding claims, wherein the aperture defined by each of the loop formations and the intermediate formation has an elongate, substantially rectangular configuration, each loop formation embracing the associated aperture and including an elongate outer portion extending along the rectangular aperture.

9. A core lamina as claimed in claim 8, wherein each loop formation has rounded outer corner zones opposite corners of the said associated rectangular aperture such that the width of each loop formation is substantially uniform throughout its length.

10. A core lamina as claimed in claim 8 or 9 insofar as it is dependent on claim 7, wherein the width of each rectangular aperture is substantially equal to the width of the loop formation.

11. A core lamina as claimed in any one of claims 8 to 10, wherein the length of the aperture is at least three times the width thereof.

12. A core lamina as claimed in any one of the preceding claims, which has a flattened figure-of-eight configuration.

13. A laminated core for a transformer, choke, lighting equipment ballast or like stationary electric machine comprising a stack of superimposed core laminae as claimed in any one of claims 1 to 12.

14. A core as claimed in claim 13, wherein a severed zone of a lamina of the stack is sandwiched between regions of adjacent laminae which are not severed.

15. A transformer, choke, lighting equipment ballast or like electric machine including a laminated core as claimed in claim 13 or claim 14.

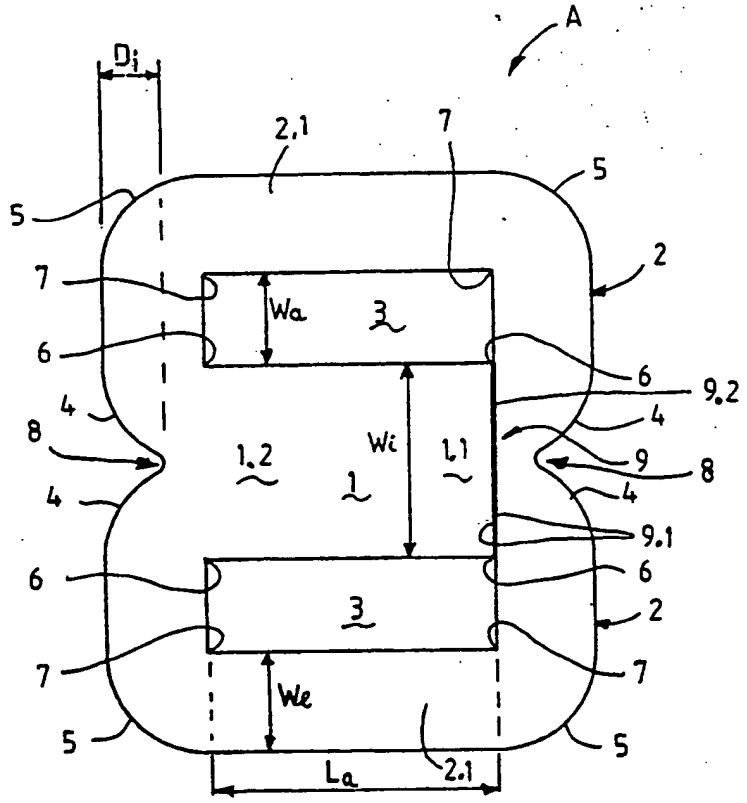


FIG 1

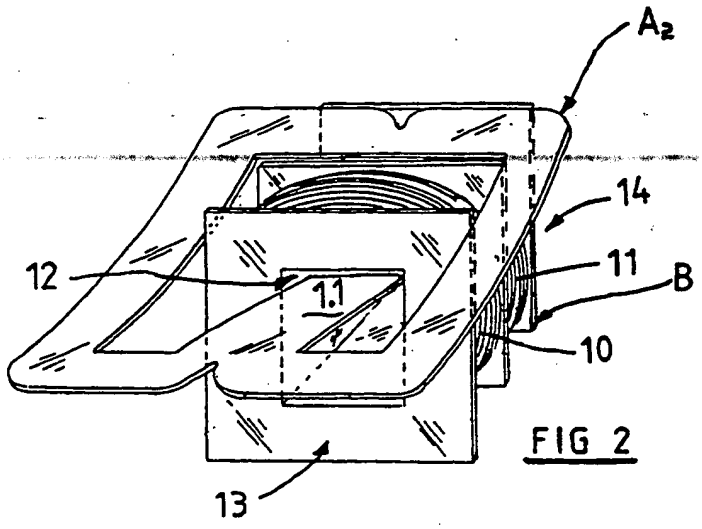


FIG 2

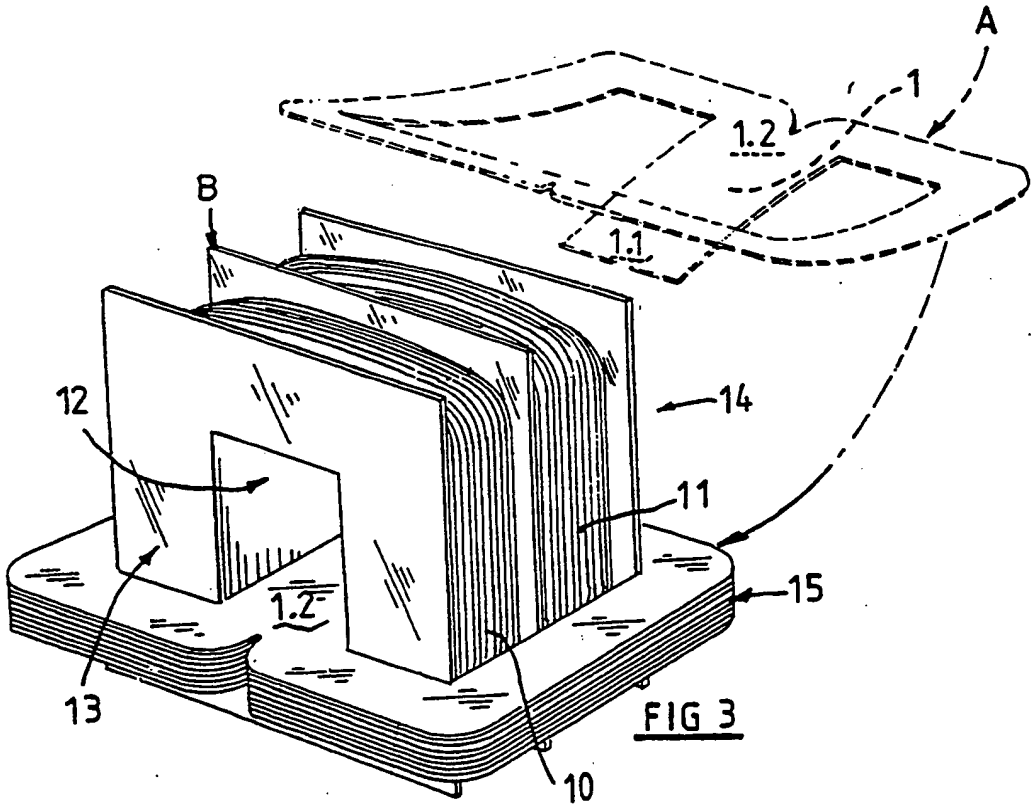


FIG 3

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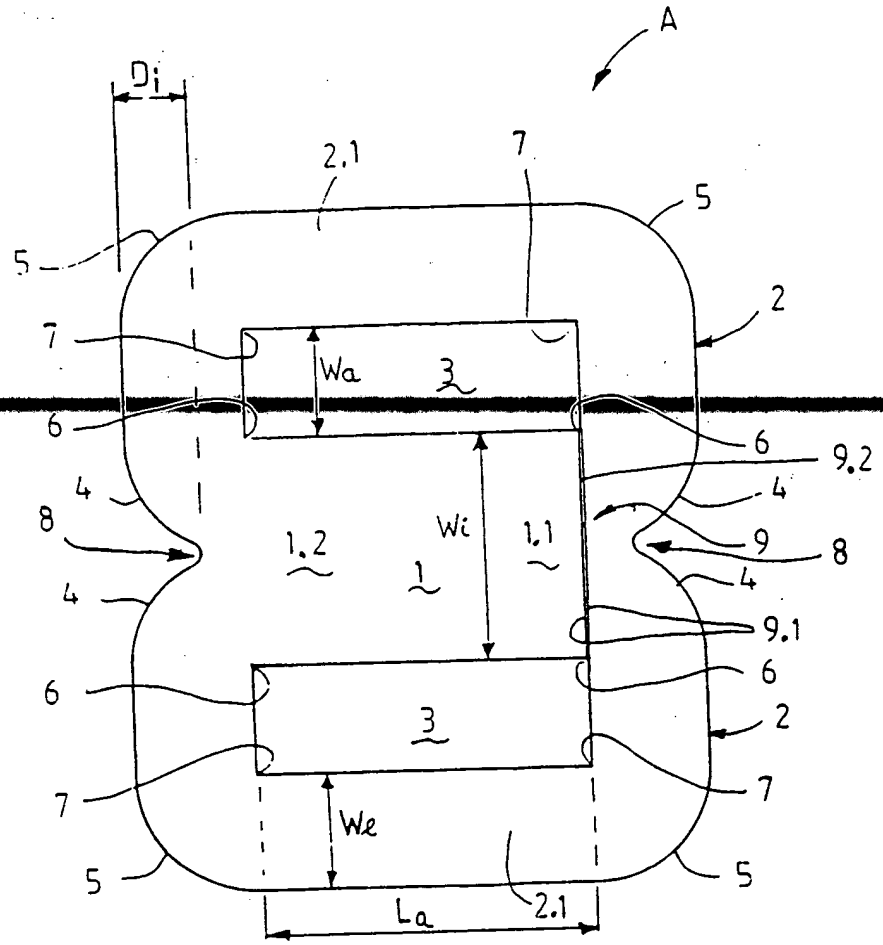


FIG 1

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number

EP 91 40 0176

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|---|---|---|
| X | FR-A-2 576 447 (BARON)<br>* page 7, line 5 - page 8, line 2; figures 1-3. * | 1-6,8, 11-15 | H01F27/24 |
| X | DE-C-678 251 (SIEMENS & HALSKE)<br>* page 2, line 29 - line 58; figure 1 * | 1,2,5,6, 8,12-15 | |
| A | DE-A-2 755 218 (PHILBERT)<br>* page 3, line 20 - line 16; figure 1 * | 1,7, 10-12 | TECHNICAL FIELDS SEARCHED (Int. Cl.5)<br>H01F |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 03 DECEMBER 1991 | BIJN E.A. |

CATEGORY OF CITED DOCUMENTS

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